ZENROBOTICS®

Robots are here
- and they are transforming the waste industry

“New smarter technologies are needed to meet the requirements of tomorrow.”

Intelligent robots will transform the industry

- FLEXIBILITY – Robotic sorting systems are multitasking. They manage several sorting tasks at the same time.
- EFFICIENCY – Robotic systems are designed for 24/7 operation and have very low operating cost.
- HIGH QUALITY – Sorting robots pick fractions with high precision. The ZRR system can be trained to recognise new high-quality end fractions.

“Robots like 3-D jobs that are Dirty, Dull and Dangerous”

Why robots?

- eliminate or reduce manual sorting
- reduce excavator sorting
- reduce logistics costs
- reduce operating costs
- increase purity
- recover new profitable fractions
- increase plant capacity
- simplify plant processes
- reduce the amount of fine fraction
- increase your profits
- safety

How is this possible?

ZenRobotics Recycler

The first commercially available robotic waste sorting system

A revolution in recycling!

- One system for multiple tasks
- Easy operation
- Simple and robust
- Very low operating cost
- Feature upgrades
- Online information of waste

Is it for me?

Yes! ZenRobotics Recycler is suitable for all companies who want to benefit from efficient and flexible robotic waste sorting.

How to install the ZRR?

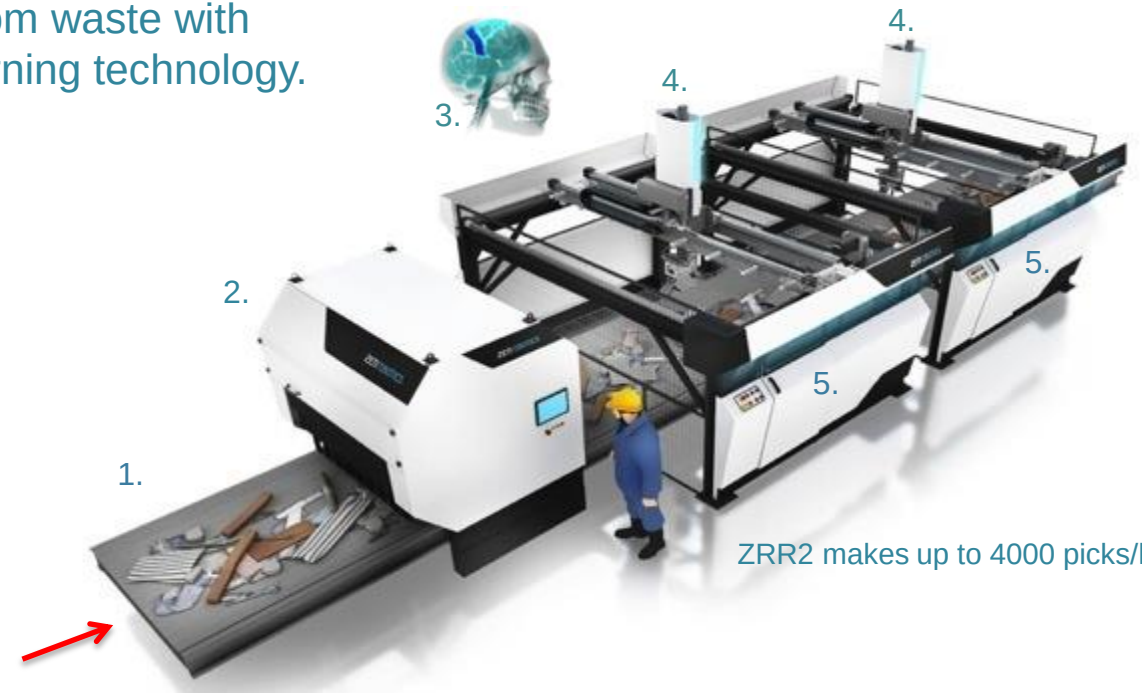
- Integrate ZRR into your existing process
- Design a future-proof process around ZRR
- Install ZRR as an independent and highly profitable Robotic Sorting Station, like the one below.

Robotic Sorting Station

ZenRobotics Recycler (ZRR)

ZRR reclaims chosen fractions from waste with industrial robots and machine learning technology.

1. Sorting belt robots automatically adjust belt speed
2. ZRR Sensor Unit contains multiple advanced sensors
3. ZenRobotics Brain Control Software in separate climatized control cabinet
4. Robot arms and Smart Gripper up to 6000 picks/h per ZRR3 unit
5. Drop-off chutes up to six chutes per arm



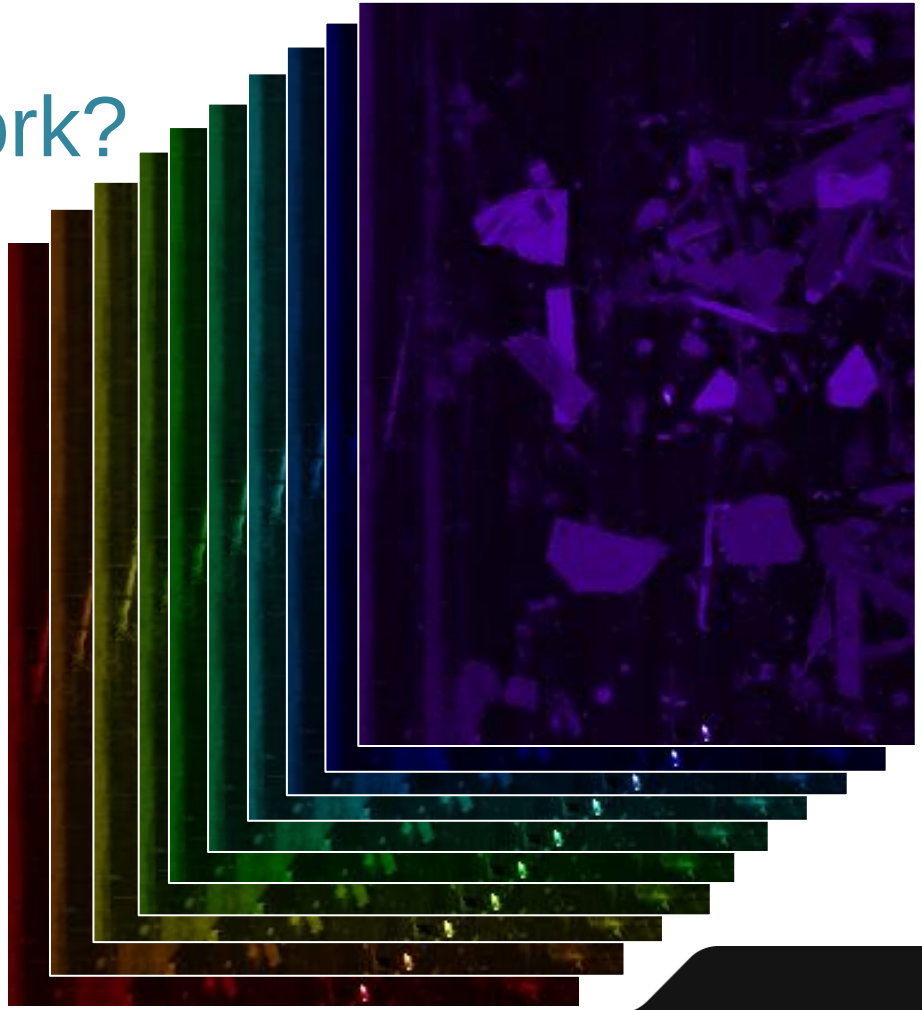
ZRR2 makes up to 4000 picks/h

How does it work?

#1 Imaging Sensors
Visible Light Cameras

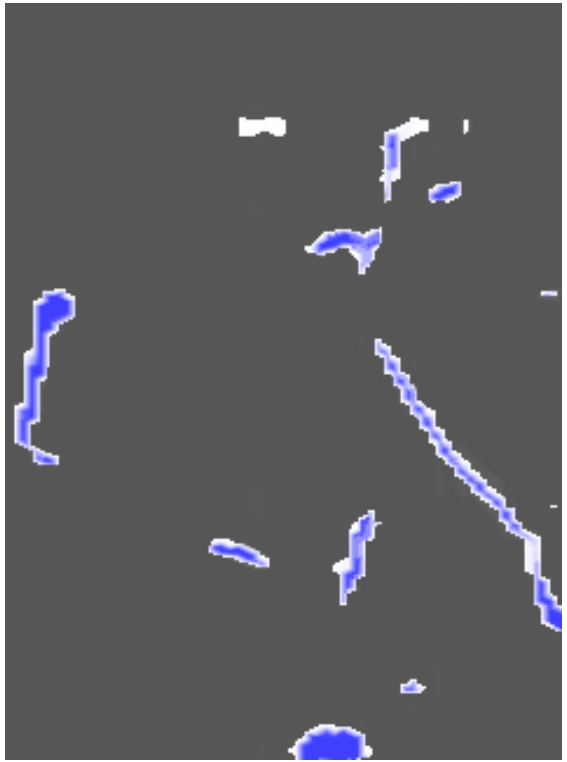
How does it work?

#2 Imaging Sensors
Spectrometer (Near Infra-Red and Visible)



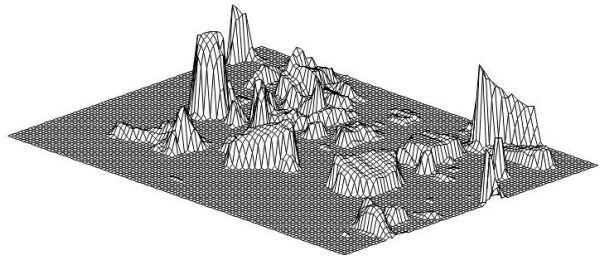
How does it work?

#3 Imaging Sensors
Multi-Coil Metal Detector



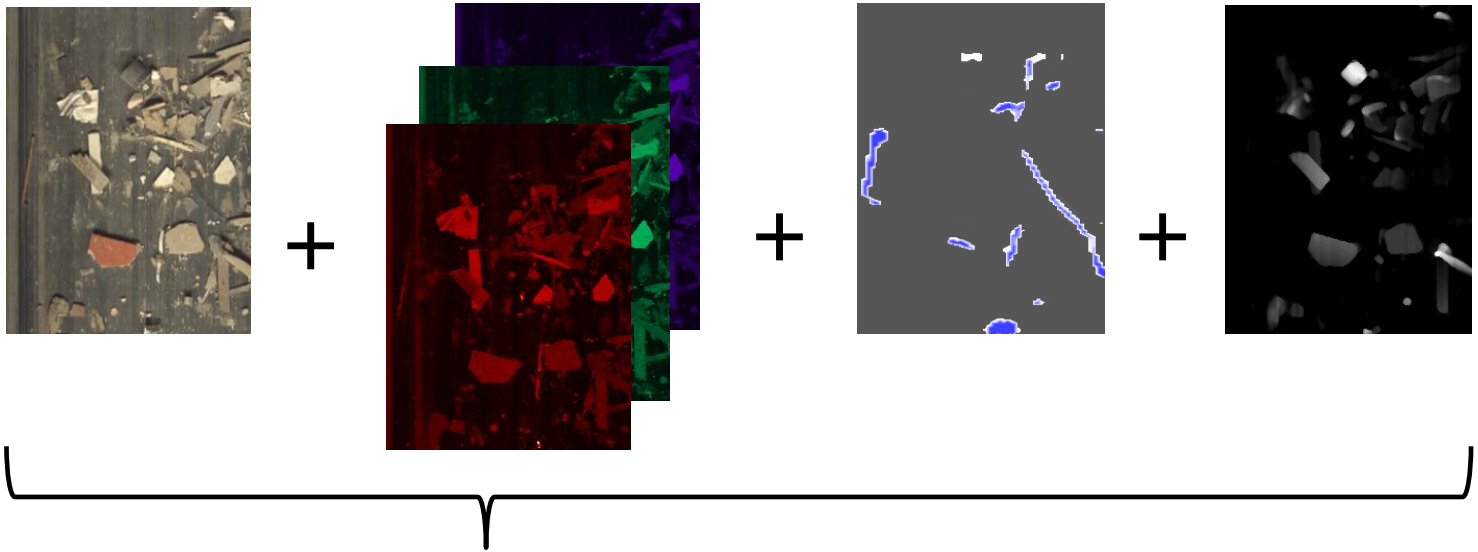
How does it work?

#4 Imaging Sensors
3D Laser Scanner



How does it work?

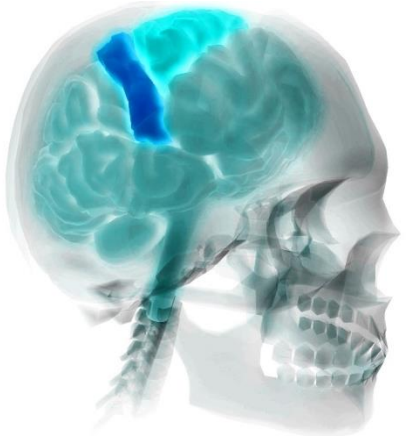
5 Sensor Fusion; Making Sense of the World Behind Sensors



Object boundaries, materials, weights, values, gripping points, …

How does it work?

ZenRobotics Brain
Segmentation =
Finding Object Boundaries



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ZenRobotics Brain
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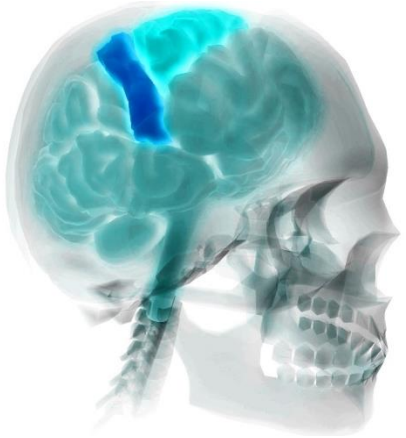
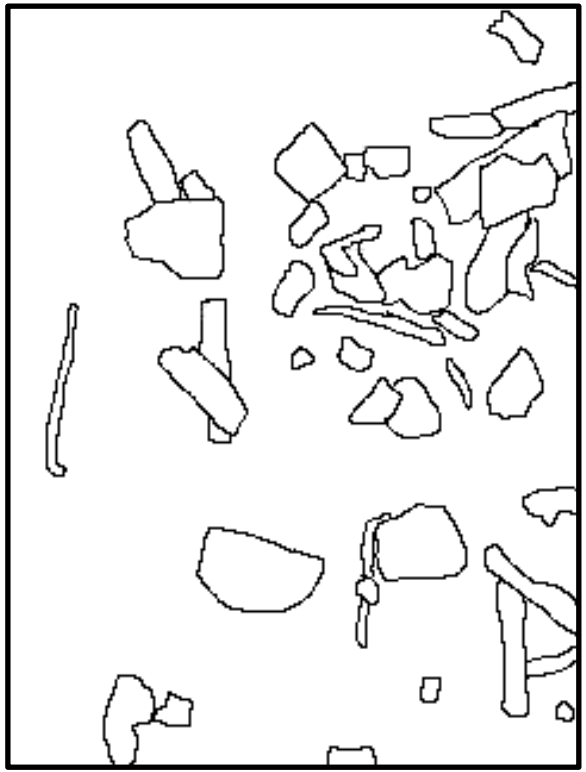
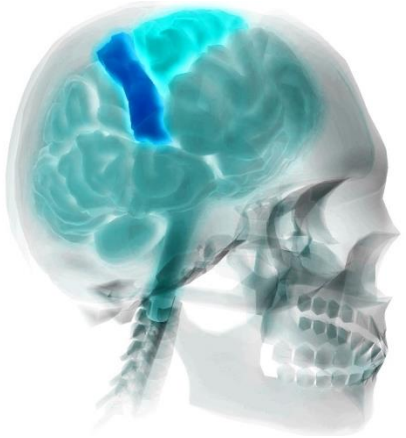




How does it work?

ZenRobotics Brain
Material Recognition



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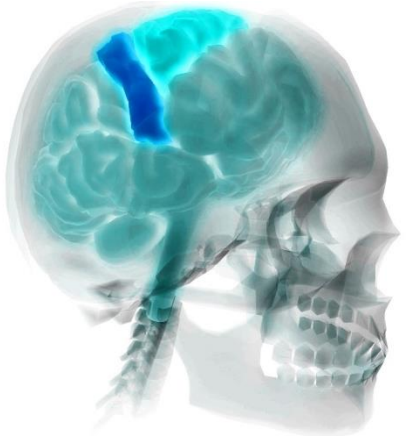
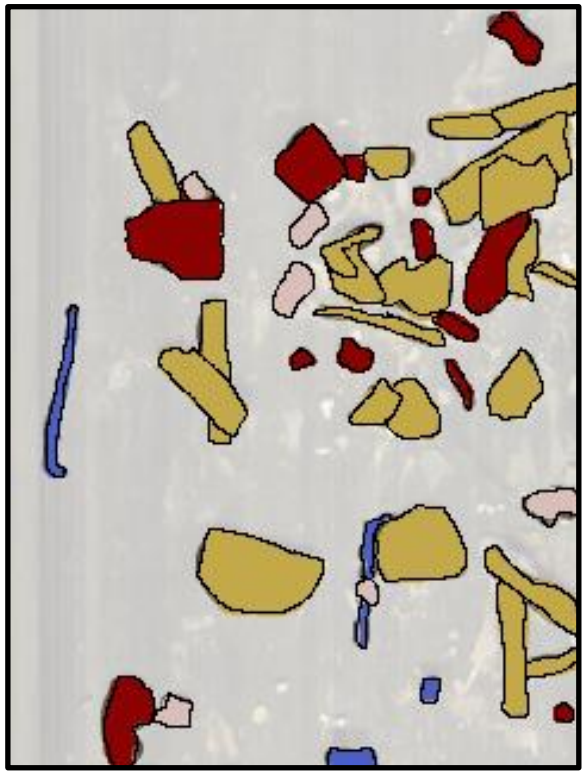
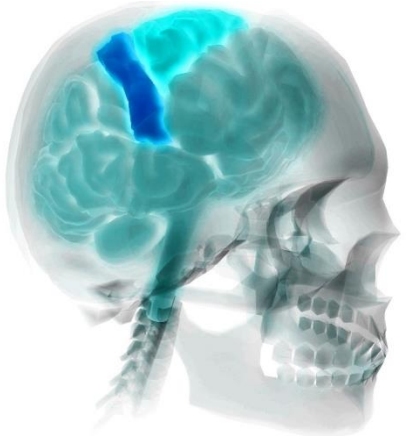
Material Recognition

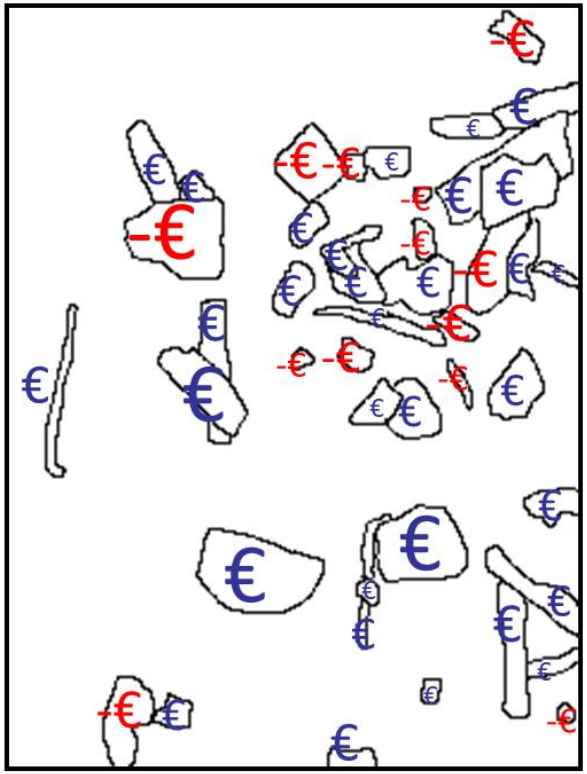




How does it work?

ZenRobotics Brain
Include volume/weight and object value estimation





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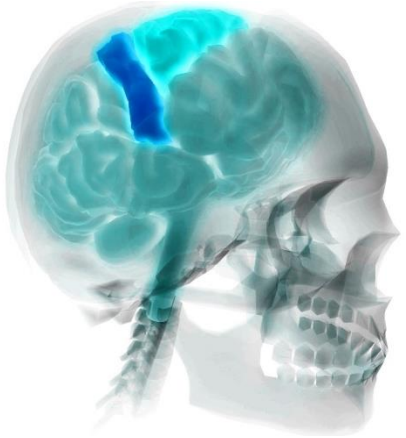
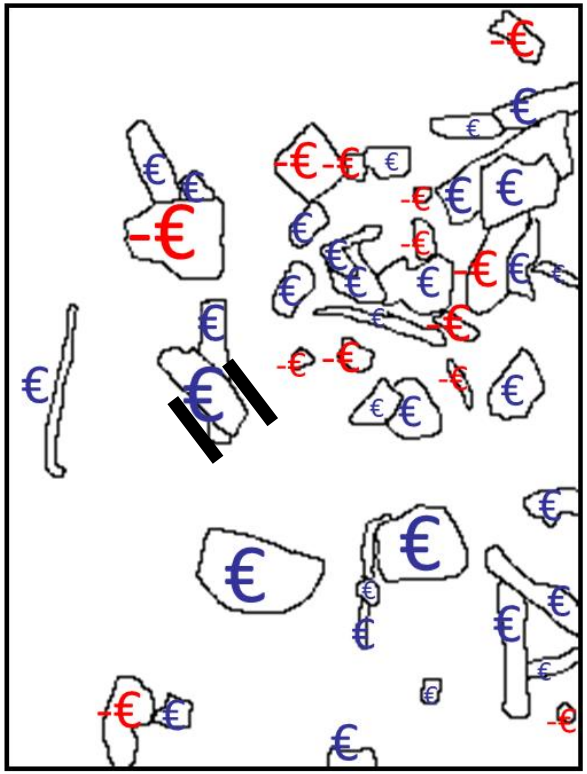
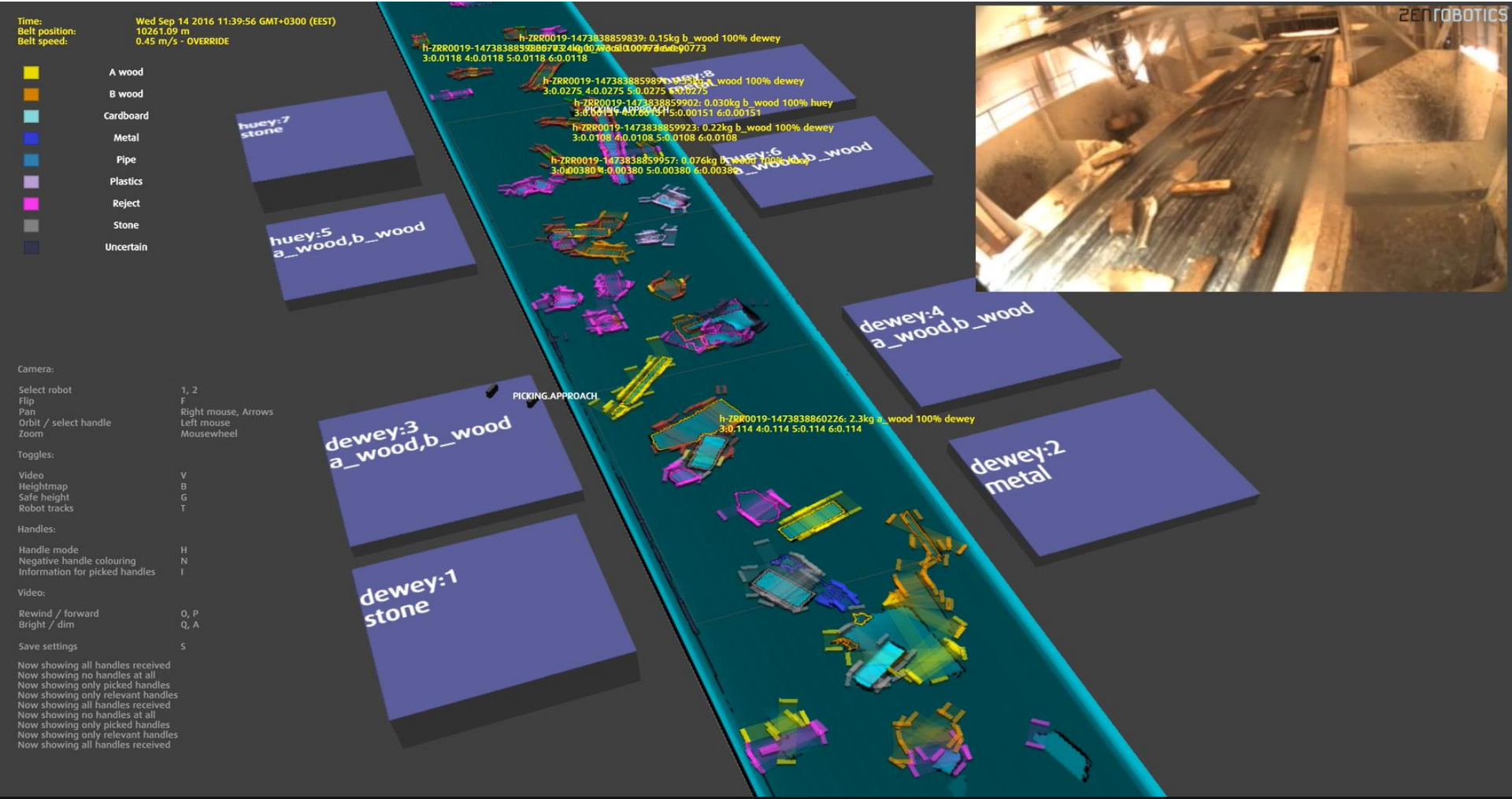





Time: Wed Sep 14 2016 11:39:56 GMT+0300 (EEST)
Belt position: 10261.09 m
Belt speed: 0.45 m/s - OVERRIDE
A wood
B wood
Cardboard
Metal
Pipe
Plastics
Reject
Stone
Uncertain
huey:7
stone
huey:5
a_wood,b_wood
dewey:3
a_wood,b_wood
dewey:1
stone
dewey:4
a_wood,b_wood
dewey:2
metal
h-ZRR0019-1473838859839: 0.15kg b_wood 100% dewey
3:0.0118 4:0.0118 5:0.0118 6:0.0118
h-ZRR0019-1473838859902: 0.030kg b_wood 100% huey
3:0.00151 4:0.00151 5:0.00151 6:0.00151
h-ZRR0019-1473838859923: 0.22kg b_wood 100% dewey
3:0.0108 4:0.0108 5:0.0108 6:0.0108
PICKING.APPROACH
h-ZRR0019-1473838860226: 2.3kg a_wood 100% dewey
3:0.114 4:0.114 5:0.114 6:0.114
ZENROBOTICS
Camera:
Select robot 1, 2
Flip F
Pan Right mouse, Arrows
Orbit / select handle Left mouse
Zoom Mousewheel
Toggles:
Video V
Heightmap B
Safe height G
Robot tracks T
Handles:
Handle mode H
Negative handle colouring N
Information for picked handles I
Video:
Rewind / forward O, P
Bright / dim Q, A
Save settings S
Now showing all handles received
Now showing no handles at all
Now showing only picked handles
Now showing only relevant handles
Now showing all handles received
Now showing no handles at all
Now showing only picked handles
Now showing only relevant handles
Now showing all handles received

Material flow

Fines < 100mm
To mechanical treatment

2D material
To RDF or material recovery

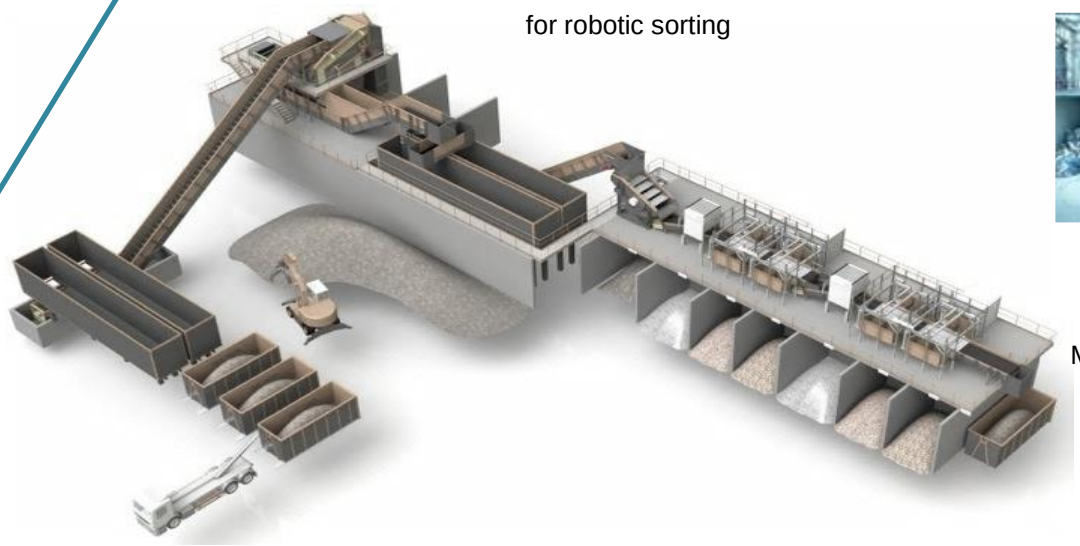
Input: Mixed Waste

Screening &
Separation
Remove fines and 2D

3D material
for robotic sorting

Storage buffer
Automatic sorting 24/7
Availability over 95%

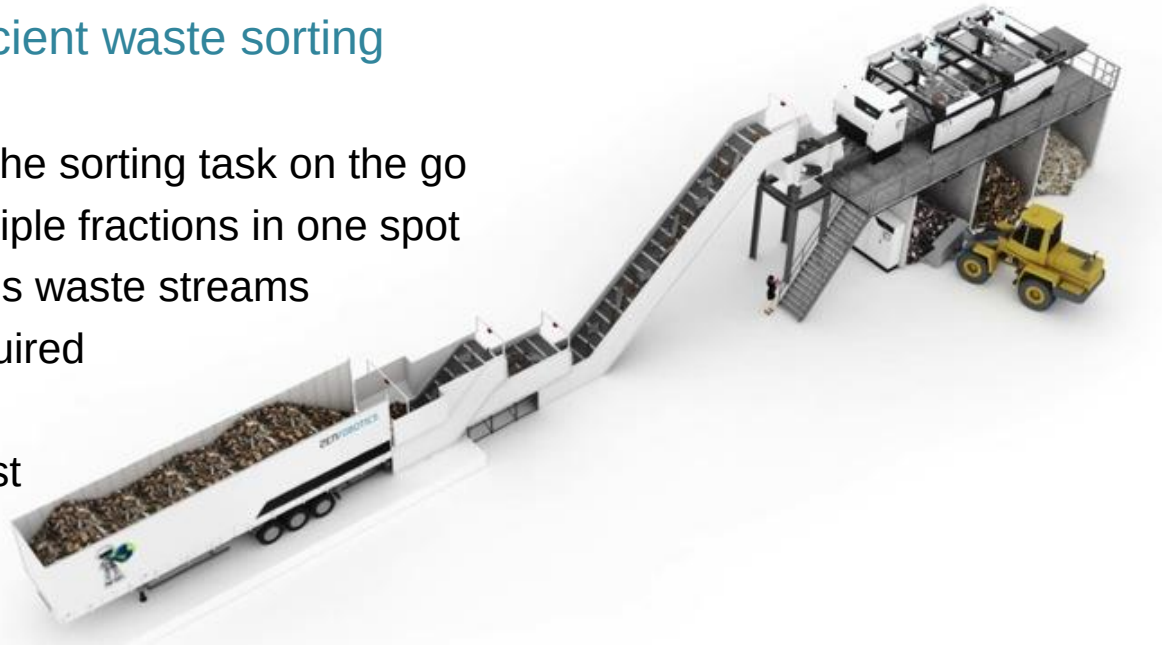
ZenRobotics
Recycler
Multiple pure fractions in
one spot



Flexible and powerful robotic sorting

Most simple process for efficient waste sorting

- Flexible operation: change the sorting task on the go
- Multitasking: Sorting of multiple fractions in one spot
- Possibility to process various waste streams
- Minimal pre-processing required
- Quick set up
- Extremely low operating cost
- Power consumption 20 kW
- Low investment



Sorting multiple fractions simultaneously in one spot

Input: Mixed waste

High quality fractions

Endless opportunities with flexibility

Concrete

Mixed inert

A-wood

B-wood

Metals
color

Mixed rigid plastics

Pipes & tubes

Plastic bags by

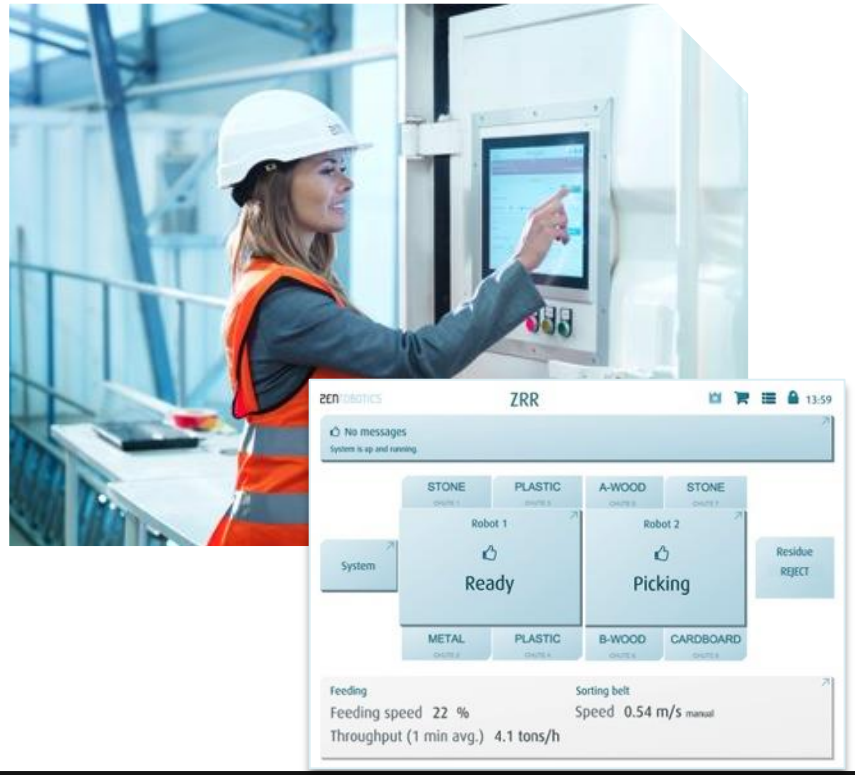
Or train ZRR to pick new fractions yourself!

What can ZRR sort? For example…

- Mixed wood
- A wood separately
- B wood separately
- C wood separately
- Inert mixed
- Inert into sub fractions: concrete, bricks, limestone, asphalt...
- Metals, ferrous & non-ferrous
- Rigid plastics mixed, also black plastic!
- Tubes & pipes by color & shape
- Old corrugated cardboard (OCC)
- Gypsum board
- Plastic bags by color, source separated MSW
- Hybrid sorting: both negative & positive sorting at the same time

Or train new fractions yourself!

Change the sorting task on the go!



- Easy-to-use User Interface (UI)
- Flexible operation: Operator can easily change the sorting task and choose desired objects to sort out
- Multitasking system: Sorting multiple fractions in one spot
- Unique flexibility in waste sorting – Allows the operator to quickly react to changes in the waste stream

Train your own ZRR

ZRR is easily trained to

- introduce a new fraction for sorting
- improve sorting quality, or
- divide fractions into new sub-fractions

Customer quote: “Working with ZRR allows us to respond quickly to changes in the quantities and properties of the input material. […] We are able to train the robots to learn and handle different types of materials which makes the system useful and profitable for us.”

Monitor and control your robots

- Easy access to site-specific performance data
- Online analysis of the waste stream and sorting results
- Key information for controlling and optimizing your production
- Easily accessed online anywhere in the world on your PC, tablet or smartphone

Performance data reporting tool

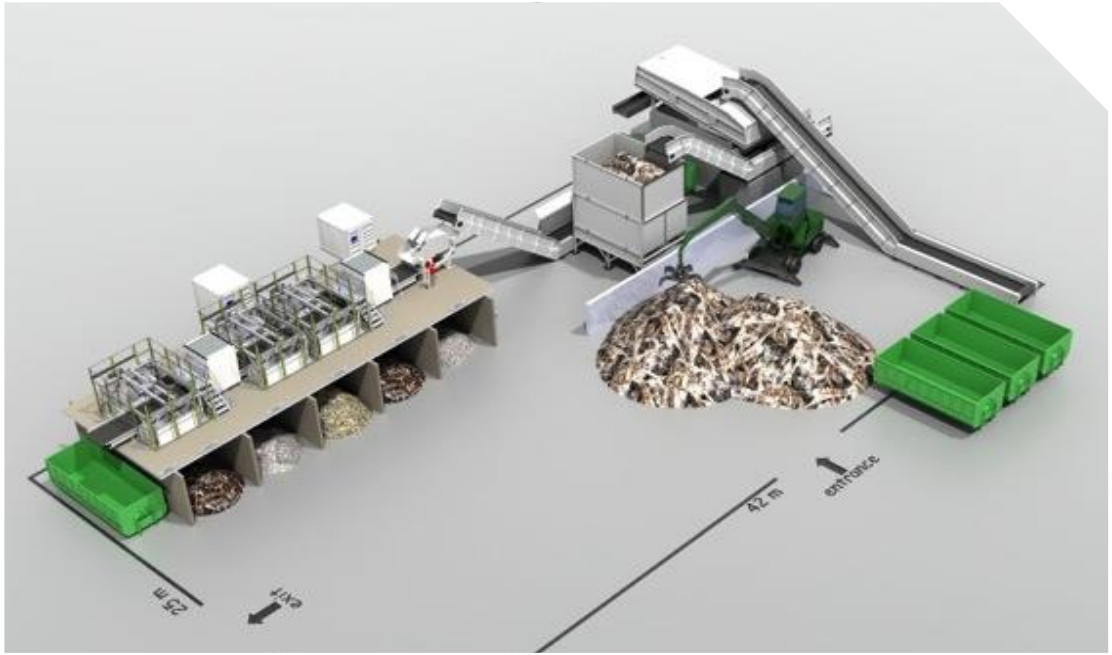
ZenRobotics customers

USA – Recon Services
NETHERLANDS – Baetsen
SWITZERLAND - Eberhard

JAPAN - Shitara Group
FRANCE - Veolia
SINGAPORE – V8 Environmental
FINLAND – SUEZ

SWEDEN – Carl F
AUSTRALIA – Sunshine Groupe
CHINA – Jiangsu LVHE

World’s first robotic sorting station



SUEZ, Helsinki

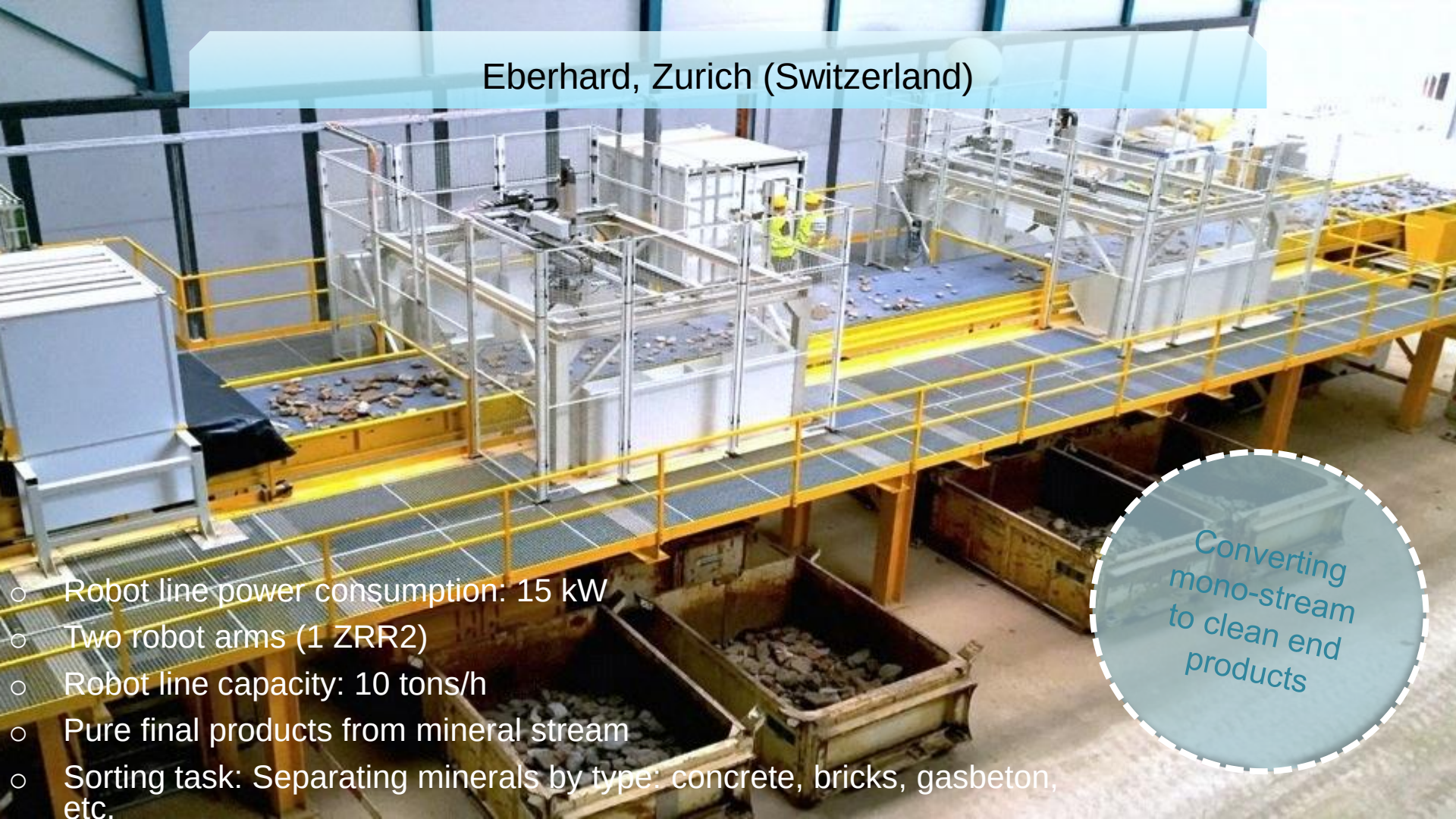
- Unmanned robotic sorting station
- Possibility to run 24/7
- Efficient waste sorting
- Low operating cost

SUEZ, Helsinki (Finland)

The most energy-efficient sorting station in the world

- Plant capacity: 15-20 tons / hour
- Plant area: 42m x 25m
- Plant power consumption: 60-80 kW
- Three robot arms (1 ZRR2 & 1 ZRR1)
- Robot line capacity: 5 tons / hour
- Sorting task: C&D (metals, wood, stone, rigid plastics)

Eberhard, Zurich (Switzerland)



- Robot line power consumption: 15 kW
- Two robot arms (1 ZRR2)
- Robot line capacity: 10 tons/h
- Pure final products from mineral stream
- Sorting task: Separating minerals by type: concrete, bricks, gasbeton, etc.

Converting mono-stream to clean end products

Sunshine Groupe, Melbourne (Australia)

- State-of-the-art plant
- Three robot arms (1 x ZRR3)
- Sorting task: wood, inert, metals, plastics

Benefitting from Most Efficient Technologies

Shitara Group, Fukaya (Japan)

Future-proof Waste Sorting

- State-of-the-art plant
- Four robot arms (2 x ZRR2)
- Sorting task: wood, inert, metals

Recon Services, Austin (Texas)

Implementing Best Available Technology & Max Capacity

- Simultaneous positive and negative sorting
- Two robot arms (2 x ZRR2)
- Sorting task: inert, metals, plastics, wood, trash

Baetsen, Son (The Netherlands)

- State-of-the-art plant
- Plant capacity: 150 000 tons / year
- Two robot arms (2 x ZRR1)
- Sorting task: wood, inert, metals

Works side-by-side with manual sorters to increase efficiency


Daitou Shoji, Fukuoka (Japan)
Plant built around robots
Extreme recovery rate

CARL F, Malmö (Sweden)

- State-of-the-art plant
- Plant capacity: 40 000 tons / year
- Two robot arms (ZRR2)
- Sorting task: wood, inert, metals, rigid plastics

24/7 operation
Not a soul on site when robots work at night. Wind powered.

ZenRobotics Recycler is powerful and fast

	ZRR1	ZRR2	ZRR3	Semi-Mobile
Robot arms:	One	Two	Three	Two
Max. picking speed (with 5 kg objects)	2.000	4.000	6.000	4.000
Picking area / robot (length/width)	2m/1,6m	2m/1,6m	2m/1,6m	2m/1,6m
Max. object weight	30 kg	30 kg	30 kg	30 kg
Max. object size (length/width)	1,5 m/0,5 m	1,5 m/0,5 m	1,5 m/0,5 m	1,5 m/0,5m
ZRR Length (incl. safety cage)	6,0 m	9,5 m	13 m	14 m
Installed power	10 kW	14 kW	18kW	16 kW

ZRR3 comes with three robot arms.

ZRR performance

Hourly performance:

Average object weight x picking speed = tons sorted

For example:

0,7 kg x 4000 picks/h = 2.8 tons/h
2,0 kg x 4000 picks/h = 8 tons/h
4,0 kg x 4000 picks/h = 16 tons/h

Multiplied by operating hours per year

There are 8760 hours in a year!

Ideal feeding improves sorting results

- To maximize recovery, ZenRobotics Brain can control the rate of material in-feed
- Material is evenly distributed on sorting belt (singularized mono layer)
- Light pre-processing
  - Remove fines (<80 - 150 mm)
  - Remove oversize materials (>1 – 1,5 m)
  - Remove 2D materials (foils, paper, cardboard, foams, carpets)
- Max throughput (t/h) depends on the density of the input material

Optimize performance and throughput

Alternative operation modes:

- Maximize throughput - increase belt speed
- Minimize reject - reduce belt speed
- Automatic Belt Speed Control: ZRR will choose the most profitable mode!
- ZRR automatically picks the most profitable objects in the waste stream.

ZRR is programmed to maximize your profit!

ZenRobotics Ltd. in brief

- Founded in 2007, ZenRobotics is the leading supplier of robotic waste separation technology
- ZRR product development since 2009
- 30 employees
- Ownership: Privately held company owned by management, employees, and long-term private equity investors
  - Invus
  - Veraventure
  - Lifeline Ventures

Next steps for robotic happiness?

1. Call sales hotline: +358 50 4363 803 or
   E-mail: sales@zenrobotics.com
2. See the robots LIVE at one of our
   reference sites
3. Let’s discuss how your operations could
   benefit from robotic waste sorting

For more information, visit www.zenrobotics.com

And check out our videos on YouTube!